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LUMINARY Memo #121

To: Distribution
From: B. McCoy
Date: 5 November 1969
Subject: What Is LUMINARY 1C

Now that 1C is out the door, maybe a discussion is needed to describe what 1C contains and some details on the fixes. The released revision number is 130.

Anomaly Fixes

L-1B-01 - The pre-designate routine in P22 uses a loop to determine when the CSM will pass inside the RR Mode II limits. An integration is made to a particular time and this time is incremented by 10 seconds every time around the loop. The anomaly was that the increment was never made; for each pass through the loop integration was done to the same time, thus never finding the CSM in the mode limits. The fix was to add this 10 seconds in on each loop pass.

L-1B-03 - Due to a coding error, the LM DAP in LUMINARY 1A and LUMINARY 1B does not control about the R axis whenever the computed jet control authorities about the Q and R axes are equal. Although these control authorities could not be equal unless the value of "HIDESCENT" or the scaling of "MASS" were changed, the logical flow was corrected to prevent the occurrance of the anomaly in future missions.

L-1B-04 - When the RR is cycled on and off, T4RUPT removes the RR ERROR COUNTER ENABLE bit, thus disabling the Forward and Lateral velocities sent to the X-pointers. The fix was to check for this bit every pass through the Landing Display Routines and reinitialize the X-pointers if the bit is missing. A note here: if this bit is being reset every second, this fix will inhibit data from being sent to the tape meter as well as the X-pointers.

L-1B-05 - R60 attitude maneuvers were to have the newly computed Mode 2 attitude errors displayed on the attitude error needles. However, the coding automatically called the mode 2 error displays before actually computing the new desired attitude in VECPOINT, thus erroneously displaying an "old" attitude's error on the needles. The new coding does not automatically call for mode 2 attitude error displays until the new attitude errors have been computed in the initial pass through VECPOINT.

L-1B-9 - Concerning here only the Landing Radar, routine R12's setting the radar activity bit causes the LGC hardware to start an 80 ms. counter which issues strobe pulses to the radar. If a Restart (hard or soft) occurs during this 80 ms, the resetting of the activity bit will stop the counter and the strobe pulses. The Restart will keep the radar from being read and so the 80 ms counter will not be reset; now, when the radar is read again, the 80 ms counter will count from where it left off on up to 80 ms and the data read in during this shortened interval will be used to update the state vector if it passes the reasonability test. The fix was to increment STILLBADH, V during the Restart; R12 will see these values are not zero and will not use the data read after a Restart.

L-1B-10 - When the ACA is returned to the detent position after being cycled in and out of detent in the manual rate command mode in a certain rapid timing sequence, the DAP may enter the attitude hold mode immediately instead of first damping the spacecraft rates as desired. The fix was to set the JUSTIN bit every time the ACA is deflected, thus always insuring Rate Damping mode when the ACA is returned to detent.

Additional Anomaly Fixes

75 - There was a 50% chance of R04 not cycling from the RR sample logic to the LR sample logic. The decision to go into the LR logic was based on the contents of RTSTDEX; now the decision is based on RTSTBASE in subroutine R04Y.

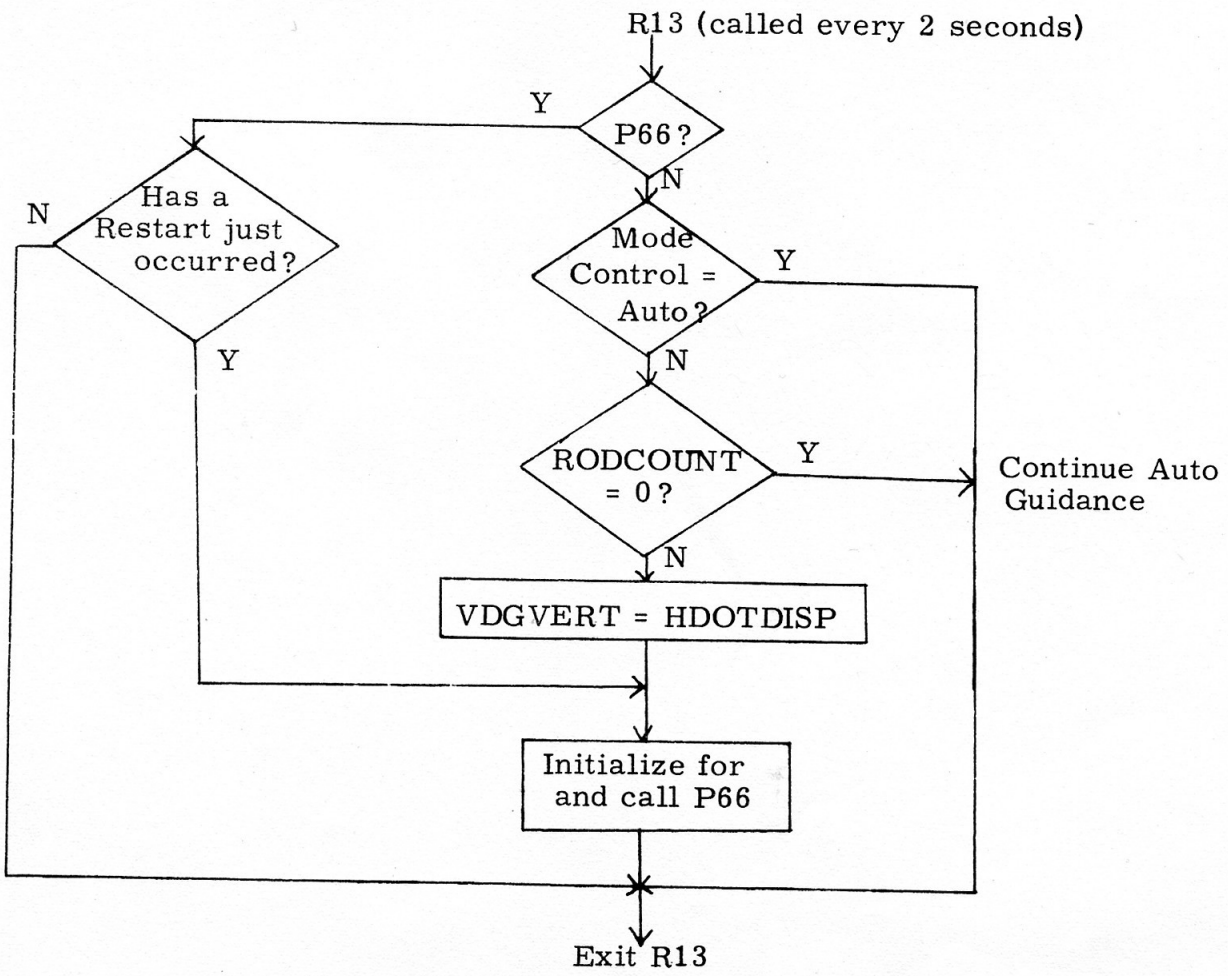
92 - Due to a certain type of extended verb (only V41 and V42 in LUMINARY) the display interface routine cannot perform these extended verb's displays if it is keyed into the DSKY during a non-flashing cyclical display, e.g. V06N40 in P40. These extended verbs did not perform a "CCS NEWJOB" before the first display. A coding change was done to add a CCS NEWJOB for every extended verb that asks whether another extended verb is going (SETXACT).

PCR's Implemented

936.2 Routine R36 used to load all zero's into the desired time of the computed out-of-plane parameters. Since these parameters are usually referenced to a particular ignition time it would be more convenient to have the routine load TIG into this desired time.

836.2 During P76's updating the CSM state vector for a burn, a V37EXXE could destroy the update if integration is still going on. P76 now sets the NODOFLAG just after the PRO to the ΔV display, thus giving a 1520 alarm if a V37 is attempted during the integration. Upon completion of the integration, the NODOFLAG is reset.

285 Selecting Manual Throttle during a descent would place the LGC in P67 with no way of returning to auto-guidance. This logic has been removed and the following logic takes its place in R13.



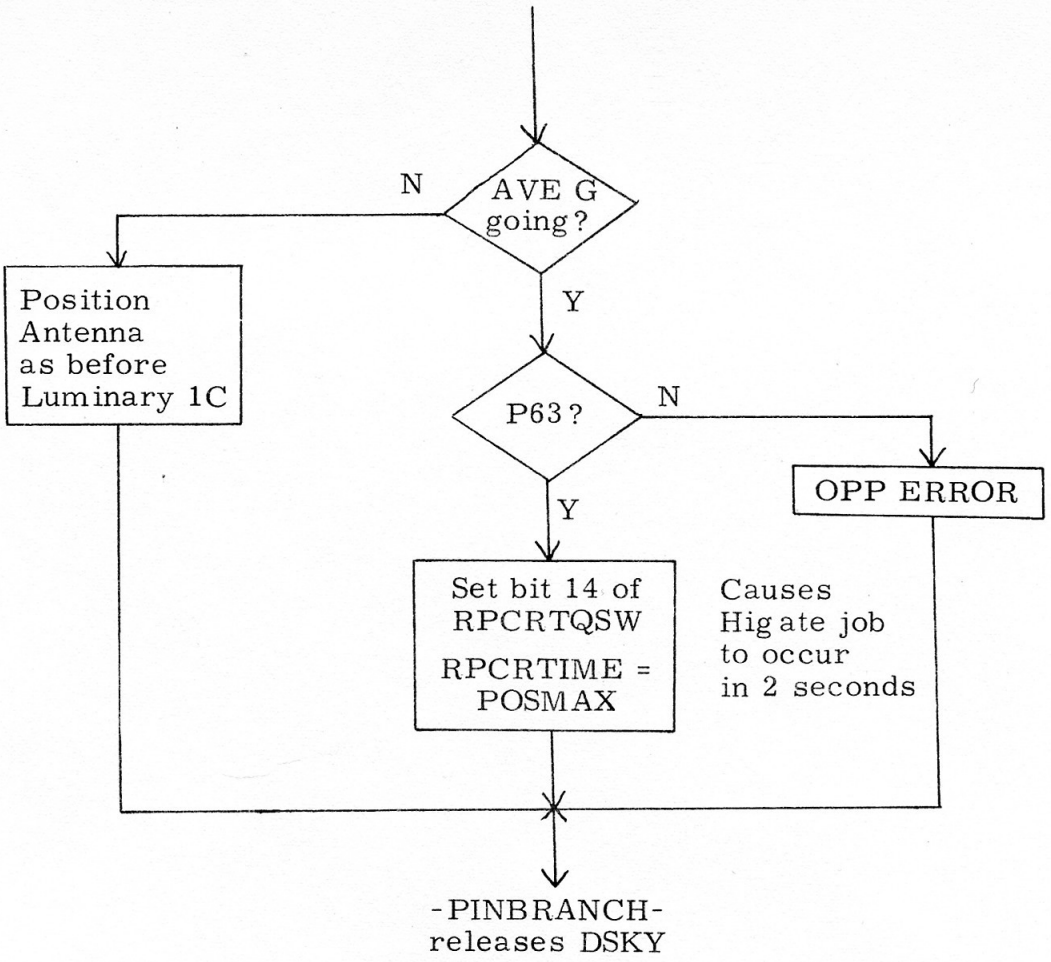
To provide the Astronaut with a display of what thrust the LGC would command if the throttle is in auto, the commanded thrust is computed as a percent every pass through the throttle equations, displayed in Register 1 of NOUN 92, XXXXX. % (R2 and R3 are HDOT and H). The erasable overlays RDOTM which is used only in P20 when reading the Radar. This percent is what the LGC is commanding, so it is probably only valid for use after throttle-down.

D. Eyles expressed caution in mode switching in LUMINARY Memo #118.

943 The Landing Radar Velocity Reasonability Test limit was moved into erasable memory so that it may be tightened to a smaller number as post-flight data might indicate. It is DP and was placed in EBANK 6. 1771, 1772 (PSEUDO address 3471, 3472); it is unshared, scaled 2(6) m/cs.

893 It was difficult for the ground flight controllers to determine which targets were used during Descent Aborts. Flagword 9 bit 7 is used to signify that the late abort targets are used (=1). It is set immediately after the decision is made to use the late targets. It is reset in V37 during DUMMYAD (just after MUNFLAG is reset).

895 Extended Verb 59 is designed to move the Landing Radar antenna from position 1 to position 2. Before LUMINARY 1C this was not allowed during PDI. The flow below shows the addition to the V59 logic.



882 NOUN 60 during P65, P66, and P67 has displayed omni-directional horizontal velocity to the astronauts. No coding change was necessary to cause the forward velocity computed for the x-pointer meter to be displayed in NOUN 60. The least significant bit is .5571 feet/second although the display in NOUN 60 is XXXX.X fps. This velocity will be the speed at which the space-craft is moving with respect to the moon's surface along the +Z (spacecraft) direction.

968 Due to variations in the LM's geometry when it is pressurized in space, the LPD markings on the window may be in error. Two erasables were added (AZBIAS, ELBIAS) to compensate for these variations. AZBIAS is simply added to the OGA command to FINDCDUW; this bias will show up in the XCDU after entrance to P64. AZBIAS's erasable location is E7, 1773, unshared. ELBIAS is

simply added to the 1/2 degree before storing in LOOKANGL. ELBIAS's erasable location is 1365, overlayed with WHCHREAD, which will not be used until Rendezvous during P20 navigation. See D. Eyles LUMINARY Memo # 118 for further details. These biases are scaled in PI radians, single precision.

806.2 Before LUMINARY 1C there was no way to change a bit in an output channel without changing all bits in that channel. NOUN 07, which is used to change flagbits, is now capable of changing channel bits using the same keystrokes, e.g.

V25 N07 E
12 E
200 E
1 E

will set bit 8 of channel 12 to a "1".

971 P12, P71, and P42 use a tailoff constant to predict when the APS engine should be shut down. This tailoff is the time it takes for the thrust to reduce to zero after the engine off command is sent. The new value is -17.65cs although the actual number in memory is -18cs.

846 rev. 1 The DPS tailoff for P70 had been using a value based on 40% of FTP, 38cs. The new value is 23.68cs, although the actual number is 24 cs.

972 The sighting error displayed in N05 was found to give valuable assistance in determining the actual landing site if only the error had direction; Viz, after sighting on a star, the star angle difference displayed in N05, except for star sighting errors, represents that component of the angular difference between the gravity and landing site position vectors in essentially the plane of the star and landing

site position vectors. Repeating this process on a second star in a different direction produces another component of the angular difference, thereby enabling one to obtain an estimate of the lat and long of the gravity vector (the true site). Thus, the absolute value instruction was removed from this sighting error display to retain its directional sign.

ACB's Implemented

#5 In the abort programs P70 and P71 the rotation control sequence is used to prevent the body x-axis from pitching through downward vertical ($-\overline{R}$) in achieving the desired thrust direction. The unit vector of this thrust direction is compared to a pad load erasable COSTHET1, and if it is greater ($\underline{U}NFC/2 \cdot \underline{X}NBPIP \geq$ COSTHET1) the x-axis is prevented from pitching through $-\overline{R}$. Now, the COSTHET1 is pad loaded zero, so the decision is always passed, even though the equation is erroneous. The fix was to unitize the thrust direction vector. Also, see Luminary Memo #116 by L. Berman and TRW Software Anomaly report A-200-G-01.

#7 There was a chance of being locked out of P66 if one of the channel bits associated with MARK X, Y or MKREJECT were stuck on, (Logic "0") A change was made to check for presence of an ROD bit rather than absence of a mark button bit in channel 16 at the entrance of MARKRUPT.

#6 In order to make room in fixing anomaly L-1B-03 an erasable was deleted as was the only instruction (Transfer to Storage) addressing this erasable (1JACCV). This erasable was a SP angular acceleration expected from a single jet fired about the V axis. In TJETLAW this acceleration is used as an average value computed from 1JACCU and 1JACCQ; thus this Transfer to Storage mentioned above is unnecessary as is the erasable itself.